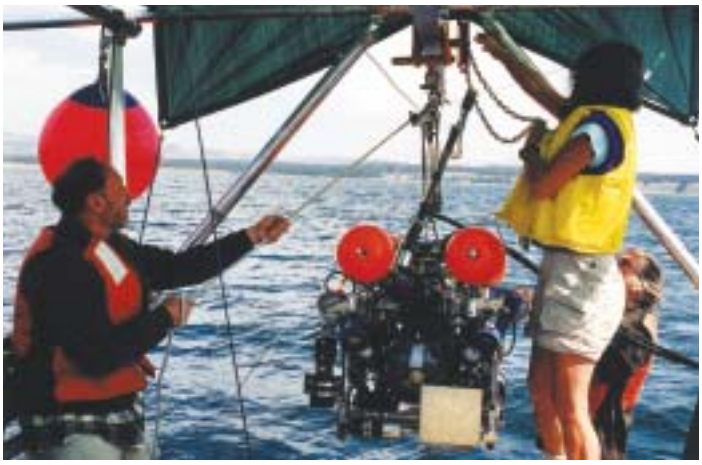
New discoveries on Yellowstone Lake's floor

By Alice Wondrak Biel with Lisa Morgan

BELOW THE WATERS of Yellowstone Lake (Wyoming), researchers have identified a spectrum of fascinating geologic features. The five-year (1999–2003) cooperative effort between the U.S. Geological Survey (USGS) and the National Park Service has resulted in a high-resolution map of the floor of Yellowstone Lake, revealing many features not recognized in previous lower-resolution maps.

Using high-resolution multibeam swath sonar imaging, seismic reflection sub-bottom profiling, and a submersible remotely operated vehicle, researchers discovered submerged faults, explosion craters, domal features, siliceous spires, hydrothermal vents, submerged paleo-shorelines, and slumped structures. Also found were rhyolitic lava flows that extend far out into the lake that are believed to be a key to controlling many morphologic and hydrothermal features in the northern two-thirds of the lake. The team produced the first geologic map of Yellowstone Lake that accurately depicts the Yellowstone caldera boundary where it passes through the lake. In short, where relief maps of the park once showed Yellowstone Lake simply as a flat blue spot in the middle of detailed topographic features, now the lake is seen as a multifeatured, topographic space. Moreover, results are providing insight into the extent of post-caldera-collapse volcanism, glaciation, active hydrothermal processes, and potential geologic hazards.



Dave Lovalvo (left), of Eastern Oceanics, along with Lisa Morgan (center) and Pat Shanks (right) of the USGS, launches a remotely operated vehicle (ROV) into Yellowstone Lake. The ROV allows direct observation and sampling of features identified in the bathymetric surveys of the lake floor.

In 2003 the research team, composed of members from the USGS and Eastern Oceanics, collected seismic reflection profiles in the Southeast, South, and Flat Mountain Arms and other areas of the lake, including hydrothermal areas. Unlike multibeam swath sonar imaging, which maps the surface of the lake floor, seismic reflection profiling penetrated the lake floor to about 80 feet (25 m), giving researchers detailed information about the physical character of the subsurface. Using a submersible, the team spent an additional five days photographing lake-floor features and sampling vent fluids and solids. The research team, joined by scientists from the University of Minnesota, also deployed a newly developed, in situ chemical sensor capable of measuring pH, temperature, and concentrations of hydrogen sulfide and hydrogen. The sensor provides information in real time about short-term variations in the composition of hydrothermal vent fluids.

"Results are providing insight into the extent of post-caldera-collapse volcanism, glaciation, active hydrothermal processes, and potential geologic hazards."

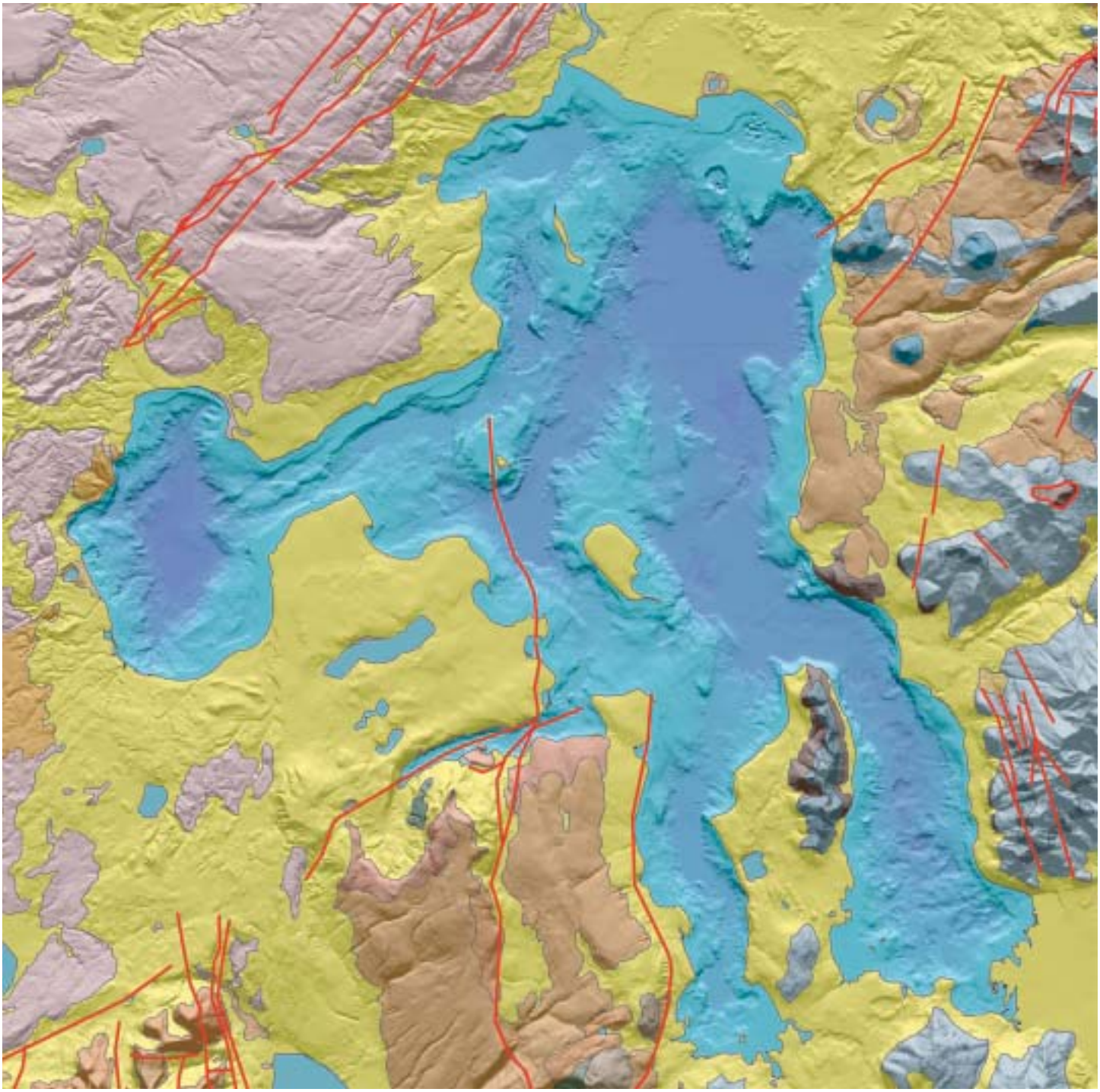
Park wildlife managers also are benefiting from these revolutionary mapping efforts. In summer 2003, research focused on areas known to be spawning habitat for nonnative, fish-eating lake trout. By understanding the seismic character of these areas, park managers hope that unknown spawning sites for this aggressive species will be identified, enabling fisheries scientists to better manage lake resources. Additionally, researchers have investigated hydrothermal vent fluids on the lake floor and the possible transmission of potentially toxic trace metals, including mercury, antimony, arsenic, and thallium, from vent fluids up through the food chain to native Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) and animals that feed on them. Examination of the mercury content of some fish revealed slightly higher concentrations than for most fish in western lakes. In addition, hair samples collected by the Interagency Grizzly Bear Study Team from two bears living near the lake showed elevated levels of mercury, whereas two bears elsewhere in the park did not. Moreover, cutthroat trout frequent shallow hydrothermal vent areas in the lake, sometimes called "trout jacuzzis." Hence, a picture of geochemistry and its effects on the ecosystem in Yellowstone is emerging.

The lake-mapping effort was one of eight interdisciplinary tasks that USGS scientists recently completed under the Integrated Geoscience Studies of the Greater Yellowstone Area Project. An 18-chapter USGS professional paper and maps summarizing the findings from this work are in press. Available publications are listed at http://minerals.cr.usgs.gov/projects/yellowstone/products.html#task7. ■

alice_wondrak_biel@nps.gov
Writer-Editor, Yellowstone Center for Resources; Yellowstone National Park, Wyoming

lmorgan@usgs.gov
Research Geologist, U.S. Geological Survey; Denver, Colorado

HIGH-RESOLUTION BATHYMETRIC RELIEF MAP OF YELLOWSTONE LAKE



This high-resolution bathymetric relief map of Yellowstone Lake (blue areas), acquired by multibeam sonar surveying, depicts hydrothermal vents, faults, explosion craters, and many other features. Researchers from the USGS, in partnership with the National Park Service, discovered the features while mapping the lake floor over the past five years. The colorful shapes surrounding the lake represent different geologic units. Red lines are faults.